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AN OUTBREAK OF THE EUROPEAN CURRANT RUST.

(*Cronartium ribicola* Dietr.)

F. C. STEWART.

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* Riverhead, N. Y.

TECHNICAL BULLETIN No. 2.

AN OUTBREAK OF THE EUROPEAN CURRANT RUST.[1]

(*Cronartium ribicola* Dietr.)

F. C. STEWART.

SUMMARY.

In September, 1906, the Station currant plantation was found to be abundantly infested with *Cronartium ribicola*, a European rust fungus hitherto unknown to America. It appeared in the form of a conspicuous orange-colored powder on the under surface of the leaves. Of 54 varieties representing three species of Ribes (*R. nigrum*, *R. rubrum* and *R. aureum*) 48 were more or less affected. It was also found on *R. grossularia* and *R. irriguum*. With the exception of a single affected leaf in a plantation one-half mile west of the Station it was not found outside the Station grounds.

In Europe this rust has been known for fifty years and is widely distributed. As a currant disease it is unimportant. The chief danger from it lies in its effect on white pines. In one of its stages (æcidium) the fungus attacks the trunk and branches of the white pine causing a serious disease called blister rust. Its

[1]Read in abstract, Dec. 29, 1906, before Section G of the American Association for the Advancement of Science at the fifty-sixth annual meeting, held in New York.

introduction into America is to be regretted. Doubtless it is a recent importation from Europe, but just how it came onto the Station grounds is not known. The only white pines in the immediate vicinity of the affected plantation are two small trees 125 feet west, planted eight years ago. Possibly these trees are the source of infection.

Remedial measures consist, chiefly, in the removal of whichever host (pines or currants) is regarded as of least value. In order to stamp out the disease, if possible, all plants of the genus Ribes on the Station grounds have been destroyed.

CIRCUMSTANCES ATTENDING THE DISCOVERY.

While passing the currant plantation on the Station grounds September 26, 1906, the writer observed an unusual appearance of the foliage on some plants. Upon plucking one of the leaves for examination we were astonished to find the under surface yellow with a rust. Even to the unaided eye it was evident that the rust belonged to the genus Cronartium and upon microscopic examination in the laboratory it proved to be *Cronartium ribicola* Dietr., a currant fungus of common occurrence throughout Europe but hitherto unknown in America.[2]

The plantation in which the rust was found is one devoted to the testing of varieties. It contains about 175 plants and includes 54 different varieties representing three species; viz., *Ribes nigrum*, *R. rubrum*, *R. aureum*. Most of the plants were set in the spring of 1903, being transplanted from another plantation about forty rods away. The remainder of the plants were set in the spring of 1904. They varied in height from two to five feet.

Of the 54 varieties, 48 were more or less rusted while the other six were free from rust. The several varieties of black currants, *Ribes nigrum*, were most affected—Monarch, Clipper and Star being among the worst and having almost every leaf thickly covered with rust. In spite of this severe attack of rust the black currants were in full foliage. Some of the red and white varieties, *R. rubrum*, also were severely attacked, but most of them were only slightly affected. The plants of this species had already lost a considerable portion of their foliage from leaf spot, *Septoria ribis*. One variety of *R. aureum* (Jelly) showed traces of rust.

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[2]Dr. J. C. Arthur informs us that the only other record of the occurrence of this fungus in North America is that of a collection made by E. Bartholomew on *Ribes aureum* in Kansas in 1892. This was a solitary collection in the uredo stage which remained unrecognized until recently. Bartholomew listed the fungus (The Kansas Uredineæ. Reprint from *Trans. Kans. Acad. Science*, **16**:193. 1897–'98. Issued June, 1899.) as *Uredo confluens* Pers., but Dr. Arthur, who has examined the specimens, pronounces it the uredo of a Cronartium, presumably *C. ribicola*.

Four varieties of *R. rubrum* (Prince Albert, Gondouin White, Stultz and an unknown variety) and two varieties of *R. aureum* (Crandall and Utah Golden) were entirely free from rust.

The infested currant plantation was adjoined on the west by a plantation of gooseberries containing many different varieties. Only one variety (Pearl) was affected and this but slightly.

In another part of the Station grounds, near the Director's residence and about forty rods east of the infested plantation, there are planted sixteen different species of Ribes, including *R. aureum*, but neither *R. nigrum* nor *R. rubrum*. Of these only one species, *R. irriguum*, was affected. There were two plants of *R. irriguum* and both were severely attacked.

A large quantity of the rusted leaves was preserved. Specimens will be distributed in Fungi Columbiani, Century 24.

DESCRIPTION OF THE FUNGUS.

The fungus *Cronartium ribicola* was first described and named by Dietrich fifty years ago.[3] It appears during the summer and autumn as a conspicuous orange-colored powder on the under surface of the leaves of various species of Ribes (currants and gooseberries). Two forms of spores, uredo- and teleutospores, are produced on Ribes leaves. The uredospores are ellipsoidal to ovoid, 19-35x14-22μ with orange-colored contents and borne in sori forming pustules. The teleutospores are elongated, unicellular and massed together into peculiar orange-colored columnar processes which attain a maximum length of about two millimeters. These processes are usually curved. To the unaided eye they appear like coarse, yellow plant hairs, hence the German name "Filzrost" (felt-rust).[4]

Another form (the aecidium form) of the currant rust fungus occurs on the trunks and branches of Pinus spp., especially the white pine,[5] *Pinus strobus*, producing a disease called blister rust

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[3]Dietrich (10). The number in parenthesis refers to the bibliography.

[4]See Plates II and III.

[5]In Europe *Pinus strobus* is universally known as the Weymouth pine, being named after Lord Weymouth who took up its cultivation actively when it was first introduced into England in 1705. (See *Garden and Forest*, 3:536. 1890.)

(Blasenrost of the Germans). The pine-inhabiting form was first described by Klebahn in 1887 as a distinct species and by him named *Peridermium strobi*.[6] Subsequently, through inoculation experiments made by Klebahn and others,[7] it was conclusively proven that *Cronartium ribicola* on the currant and *Peridermium strobi* on the pine are not separate species but only different stages of one and the same fungus.

GEOGRAPHICAL DISTRIBUTION AND ECONOMIC IMPORTANCE.

Cronartium ribicola occurs in several European countries, and probably in India;[8] but has never been found in Australia or in South America and in North America but once as mentioned on page 63, footnote 2.

It was originally described in 1856 from specimens collected in western Russia. Since that time it has been reported from other places in Russia even to the Ural Mts.[9] on the east and to the Caucasus Mts.[10] on the south. In Germany it is common and the injury which it does to the white pine is of considerable economic importance. Klebahn[11] has reported a destructive outbreak of the disease among white pines in the vicinity of Bremen in 1887. Tubeuf,[12] in 1898, stated that specimens of it were to be found all over Germany and that it was destructive in the northeastern part. Among other instances of severe damage he mentions a large nursery near the Holland border in which the culture of white pines had been entirely given up on account of the fungus. In another publication the same author stated that the disease was spreading and becoming a serious menace in Germany.[13] Eriksson[14] describes its epidemic occur-

[6]Klebahn (23).

[7]Klebahn (24, p. XLIX), (26), (27, p. 31), (29, p. 333), (30, p. 74), (32, p. 16), (35, p. 86); Rostrup (53, p. 187), (54); v. Wettstein (67); Sorauer (58); Eriksson (13, p. 380); v. Tubeuf (64); Hennings (20); Schöyen (56).

[8]Tulasne (66, p. 189), mentions a Cronartium on Ribes in India.

[9]Sorokin (59).

[10]Speschneff (60).

[11]Klebahn (24, p. XLV).

[12]v. Tubeuf (63).

[13]v. Tubeuf (61).

[14]Eriksson (12).

rence in Sweden. Bos[15] states that in Holland it is so abundant that in many localities the culture of white pines is impossible. It is also reported from Belgium,[16] Denmark,[17] Norway,[18] Switzerland,[19] France,[20] Austria[21] and England.[22]

Judging from the European literature on the subject, it appears that as a currant disease *Cronartium ribicola* is regarded as of little importance even in those regions in which it is abundant, but as a disease of white pines it has caused much damage.

American mycologists, believing that it must eventually make its appearance in this country, have been on the lookout for it for many years; but with the exception of the Bartholomew collection previously mentioned (footnote 2, p. 63) it has not been found anywhere in the Americas. No Cronartium on any species of Ribes and no Peridermium on *Pinus strobus* are known to America. The fact that America is the home of the white pine makes the absence of *Cronartium ribicola* especially noteworthy. Magnus,[23] Klebahn,[24] and others have commented upon this and discussed the probable origin of the fungus. The most plausible theory advanced regarding the origin of *Cronartium ribicola* is that its original host was the Swiss stone pine, *Pinus cembra*, and that it was introduced into Germany in recent times from Russia where *Pinus cembra* forms extensive forests. Schellenberg[25] expressed the opinion that it is also indigenous in the Swiss Alps on *Pinus cembra*.

It is altogether probable that the apparent absence of *Cronartium ribicola* from America is real; or at least the fungus cannot have existed here long. It is unlikely that collectors have overlooked it. Both on the currant and on the pine it is conspicuous and

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[15]Bos (5).
[16]Nijpels (44); Marchal (41), (42).
[17]Rostrup (53).
[18]Blytt (7); Schöyen (56).
[19]Fischer (15); Schellenberg (55).
[20]Poirault (51).
[21]v. Wettstein (67); Bubák (8).
[22]Plowright (48), (49), (50).
[23]Magnus (36), (37), (39), (40).
[24]Klebahn (25), (26), (30, p. 155), (34, p. 78).
[25]Schellenberg (55).

PLATE I.—THE EXPERIMENT STATION CURRANT PLANTATION IN WHICH THE OUTBREAK OF RUST OCCURRED.

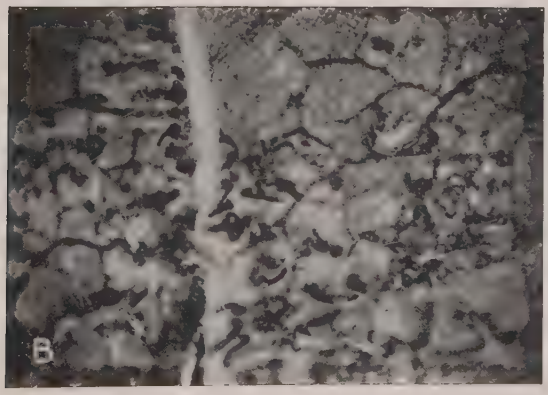

PLATE II.—THE UNDER SURFACE OF RUST-INFESTED CURRANT LEAVES.
A. UREDO AND TELEUTO SORI OF CRONARTIUM RIBICOLA (×4).
B. THE SAME, MORE ENLARGED.

PLATE III.—THE CURRANT AND PINE RUST,
Cronartium ribicola.

1, Uredo and teleutospore stages on leaf of black currant; 2, Uredospores, *a*, and telutospores, *b*, cemented together to form an erect, hairlike structure (×50); 3, Uredospore, (×300); 4, Four teleutospores, two of which are germinating, and one of the germ-tubes has produced four sporidia or secondary spores (×300); 5, Aecidia on bark of white pine; 6, Aecidiospores (×300). (After Massee.)

readily identified. The horn-like masses of teleutospores are characteristic and serve to distinguish it from other rusts occurring on Ribes leaves.

ORIGIN OF THE GENEVA OUTBREAK.

It would be interesting to know the origin of the outbreak at Geneva, but from the data now in hand it is not possible to locate definitely the original source of infection. It is likely that the fungus was imported with pines rather than with currants or gooseberries, since it is perennial within the stems and branches of the pine, while on Ribes it is confined entirely to the leaves. The only white pines in the immediate vicinity of the diseased currant plantation are two small trees standing 125 feet to the west. These were purchased from a Geneva nursery and set eight years ago. From a careful examination of these trees made in November they appeared in thrifty condition without any indication of Peridermium. Nevertheless, they may be the source of infection, notwithstanding their seeming freedom from disease. *Peridermium strobi* should be sought in April and May; by November it is difficult to recognize.

The two trees just mentioned are the only white pines on the Station grounds; and there are no specimens of *Pinus cembra*, *P. lambertiana*, *P. monticola* or any other Pinus having leaves in clusters of five. The nearest other possible sources of infection are a 12-feet-high *Pinus strobus* sixty rods east, an aged *Pinus strobus* about eighty rods north and a sixteen-year-old *Pinus cembra* the same distance to the southeast. There are several nurseries in the vicinity of Geneva and it may be that some one of them has imported diseased pine trees. The nearest nursery containing pines liable to the disease is about one-half mile west of the Experiment Station. It contains a block of *Pinus cembra* and some *Pinus strobus* imported from France. Here may be the source of infection. However, contradictory evidence is found in the fact that a plantation of red currants (*Ribes rubrum*) directly across the road from this nursery was practically free from Cronartium. A careful search revealed just one leaf affected with *Cronartium ribicola*, which was in the teleuto stage. Another plantation of red currants between the nursery and the

Experiment Station was entirely free from Cronartium. In fact the single affected leaf above mentioned is the only instance in which the Cronartium has been found outside the Station grounds although the neighboring currant plantations were carefully searched. Thus, the indications are that the source of infection is on the Station grounds.

This raises the question whether it is possible that the outbreak may have resulted from uredo- or teleutospores brought onto the Station grounds with imported currant plants. During the past ten years the Station has made several importations of currant and gooseberry plants, the latest one being from Hexham, England, in the spring of 1904. Can these plants have been the source of infection? It has already been stated that the aecidium stage of *Cronartium ribicola* occurs on certain species of Pinus, especially *P. strobus*. It has been proven that the uredo stage on the currant may start from infection with aecidiospores from the pine; and that the aecidium stage on the pine may result from infection with teleutospores from the currant.[26] Further, it is believed, but not conclusively proven, that aecidiospores can not infect pines and teleutospores can not infect currants. The uredospores may infect currants directly, but they do not survive the winter. In short, in the absence of pines the currant rust can not perpetuate itself. This is the generally accepted view and if it is a correct one the Geneva outbreak of currant rust could not have come directly from imported currants. However, some eminent mycologists have expressed doubt on this point. Eriksson,[27] Fischer,[28] Iwanoff,[29] Nilsson,[30] and Speschneff,[31] have all cited cases of the occurrence of *Cronartium ribicola* on currants in localities where *Pinus strobus* was lacking; and Eriksson,[32] particularly, has expressed the opinion that it may live from year to year on currants entirely independent of the

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[26]See references given in footnote 7.
[27]Eriksson (13 p. 382).
[28]Fischer (15).
[29]Iwanoff (22, p. 99).
[30]Nilsson (45).
[31]Speschneff (60).
[32]Eriksson (13, p. 392).

aecidium stage on the pine. Klebahn,[33] on the contrary, believes that this view should not be accepted without thorough investigation. In none of his numerous inoculation experiments was there a recurrence of Cronartium the following season. In our own case the outbreak on currants can not be satisfactorily accounted for except on the assumption that the two nearby *Pinus strobus* trees were diseased last spring. It may be possible to determine this point next spring. If it can be proven that these trees were free from Peridermium in the spring of 1906 then it would seem that we have here evidence in support of Eriksson's view; for it is scarcely possible that pine trees sixty rods or more distant can have been responsible for so abundant an infestation.

ATTEMPT AT ERADICATION.

In order to stamp out the disease, if possible, every Ribes plant on the Station grounds has been destroyed. The two white pines standing by the currant plantation, also, will be destroyed if they show the disease next spring. A careful watch will be kept over pines and currants in the vicinity of the Station and in case of the appearance of the disease next season measures will be taken to secure the prompt destruction of all affected plants. Perhaps the disease may be stamped out, but the chances are against it. The writer knows of no record of a successful attempt at the complete eradication of a fungus disease of plants. It is rarely attempted.

Even should this attempt prove successful, it can not be expected that the disease can much longer be kept out of America. Considering the frequency with which pine trees are imported it is a wonder that the disease has not made its appearance here before.

ITS PROBABLE IMPORTANCE IN AMERICA.

It is improbable that growers of currants and gooseberries in America have much to fear from this new disease. Even when currant leaves are abundantly infested with the rust fungus they appear to be but little injured by it. On the Station grounds

[33]Klebahn (33).

black currants which were badly infested held their leaves until well into October.

The chief danger from *Cronartium ribicola* lies in its effect on pine trees, particularly the white pine. In parts of Europe it has wrought havoc among white pines and there is no apparent reason why it should be less destructive in America should it become established here. Indeed, it may become even more destructive. It has not infrequently happened that a parasitic fungus introduced into a new country has become more virulent in its attack and caused greater damage than in its native country.

There is also the possibility that it may extend its list of host plants. In Europe it is known to attack only four species of Pinus;[34] viz., *P. strobus*, *P. cembra*, *P. lambertiana and P. monticola*, all of which bear their leaves in clusters of five.

TREATMENT.

Since it is probable that pine trees and Ribes plants are both necessary to the perpetuation of the Cronartium, the destruction of all specimens of either of these two kinds of host must result in the extermination of the rust. Accordingly, the principal method of control recommended by European writers is the destruction of whichever of the two hosts is the least valuable. Wherever there is danger of the disease, currants or gooseberries should not be planted near white pines.

It is possible that on currants and gooseberries the rust might be controlled by spraying with bordeaux mixture, but no experiments have been made. On the Station grounds one application of bordeaux mixture made as soon as the fruit had set apparently had no effect on the rust.

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With the appearance of *Cronartium ribicola* in this country there is likely to come renewed interest in it. In order to facilitate the labors of American mycologists who wish to examine the literature of the subject, the following bibliography has been

[34]Klebahn (34).

compiled. It is not quite complete and several of the articles have not been seen by the writer. By far the most important of the references given is Klebahn's book, Die wirtwechselnden Rostpilze, which contains an authoritative resumé of the whole subject with numerous citations of literature.

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